STUDY PROJECT

DREDGING: KEY LINK IN THE STRATEGIC NATIONAL DEFENSE

BY

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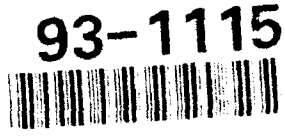

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Our national security strategy envisions a robust and growing economy, wise environmental stewardship, and a strong military as part of its plan to meet the nation's security needs in the 1990's. As a seafaring nation, ports play a strategically important part in our nation's trade, economy and defense. Dredging to keep access to these ports has become technically complex, legally difficult and essential to the future vision of our leadership to revitalize the nation's economy. Today the Army Corps of Engineers has primary responsibility to dispose of our 450 million cubic yards of dredge material in an environmentally sound manner. All maritime activities in the United States face a tremendous challenge in the future. Solutions to the dredge disposal issues must be found that allow us to keep our channels open but do not result in environmental degradation. The Long Term Management Strategy for the disposal of dredge material brings all interested parties together to arrive at a 50 year plan to insure the viability of this key link in our National Defense. This paper looks at the strategic importance of dredging and why our ports are in jeopardy if a solution is not found.

USAWC MILITARY STUDIES PROGRAM PAPER

DREDGING: KEY LINK IN THE STRATEGIC NATIONAL DEFENSE

AN INDIVIDUAL STUDY PROJECT

by

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INTRODUCTION

The United States is a seafaring nation and our ports play an important role in our Nation's trade, economy and defense. Since the founding of the country, the United States has been dependent upon water transportation for its trade. Every major metropolitan region of the United States centers around a port or is linked directly by rail or canal to a port facility. The end result has been the creation of a network of ocean, Great Lakes and river ports, which link our nation's centers of commerce, trade, industry, distribution, education, and culture.[1]

This paper will examine the strategic importance of dredging, a key link in maintaining access to these ports, and describe why upgrading of water transportation infrastructure in the United States and maintenance of these facilities is in jeopardy. Dredging is seen by most people as innocuous, uncomplicated and merely a "housekeeping activity", however, it is just the opposite.[2] It is technically complex, legally difficult and is essential to the future vision of our leadership to revitalize the Nation's economy. Dredging is inconsequential to most people because it is not a commonly observed event, but it has become an environmental, economic, and political battle ground for competing interests. Today's economic threat does not come from another nation's navy or some terrorist organization, but stems from our inability to efficiently accomplish the mundane task of dredging to allow ships access to our nation's centers of commerce.

DEFINITION

A simple definition of dredging is the underwater excavation of soils and rock. This process consists of excavation, transportation, and disposal or reuse of the dredged material. Disposal of dredged material has become the real problem. The environmental and legal problems have become extremely difficult and seemingly impossible to resolve with the present bureaucratic institutions.[3]

HISTORICAL PERSPECTIVE

Ports, harbors and inland waterways have been of strategic importance throughout history. Geographers, historians and military leaders have recognized that it is critical to have these facilities clear of silt and debris. A country with outlets to the sea has a major economic advantage over land locked countries: comparatively speaking, sea transportation is cheap and reliable. Navigable rivers serve as economic lifelines, tying a country together and boosting international trade. Examples include the Rhine, Danube, and the Yangtze which have extensive inland waterways systems.[4]

To demonstrate the importance of dredging, one can look at historical examples. During biblical times, the largest city in the Roman province of Asia was Ephesus. This city was a thriving seaport, but silt brought down the mountain by the Cayster River gradually filled the harbor. A few channels were kept open by dredging, but the port gradually lost its importance. Today, Ephesus is eight miles from the coast, separated by marsh.[5]

Peter the Great battled for years to obtain Russian outlets on the Baltic and Black Sea.[6] The strategic importance of access to the seas has been seen in a much more recent example. In his book, General Schwarzkopf discusses a visit he had to Kuwait in 1989, as he was taking command of Central Command. As he talked to General al-Sanii about the Iraqi threat, the Kuwaiti general noted that the Shatt al-Arab waterway had not been dredged for the entire course of the Iran war, and was so full of silt, sunken ships, and unexploded artillery shells, that it would be unusable for years. He felt that Saddam Hussein was very likely to try and seize the port area near the Kuwait City of Babiyin Island to insure his access to the Persian Gulf. Dredging of the other channel would have allowed ample access to the sea and might have made the strategic objectives of Kuwait less necessary for Saddam Hussein.[7]

The strategic importance of ports and access to ports is recognized by leadership because economic chaos occurs when the infrastructure of a developed region fails to keep pace with the demands placed on it by rapid economic growth and necessity.[8] The need to move commerce cheaply and efficiently becomes critical to a nation's survival.

The United States, too, has seen a need to transport people, equipment, materials, and commodities by water. Dredging became necessary to increase the channel depths of many of our own waterways to provide access to certain ports and harbors. As ships grew, so did the need for dredging deeper channels, turning

basins, and berthing areas. Regular maintenance dredging became necessary to keep these facilities at the required depth. In earlier days, the difficult part of dredging was the engineering and transport of the material. Often times the material was simply cast to the side of the channel, or moved a short distance for disposal. Environmental considerations were unheard of, and the most inexpensive engineering solution was used. This dredging process played a vital role in maintaining the economic well-being of the United States and its development and allowed low cost transportation.[9]

Dredging and maintaining access to our waterways has historically been the responsibility of the U.S. Army Corps of Engineers. They have the responsibility to dredge for the Federal Government, to contract its accomplishment, and to regulate all private elements during dredging operations. The question is often asked, why the Army is interested in waterways and how does this task relate to the national defense? The reason has evolved over the past century and its significance to our strategic defense is taking center stage as our economy moves to the top of the governmental interest list.

It was not until after the Civil War that the Federal Government's role in maintaining waterways was officially codified. Before 1790, states had the power to collect tolls from interstate commerce in order to recover project costs.[10] In 1808, the first comprehensive study was done to recommend an elaborate system of canals and waterways to develop the nation

and to strengthen its union. The Army had experienced great transportation and logistic problems during the War of 1812, and the Army Corps of Engineers was tasked to evaluate these problems following that war.

The Corps study, completed in 1816, clearly indicated the need for improvements to the water transportation system for economic and military reasons. The study concluded that the national defense should rest upon four pillars: a strong Naval force, a highly mobile regular Army supported by reserves and National Guard, invincible defenses on the seacoast, and improved rivers, harbors and transportation systems that could permit rapid movement to meet the enemy and swifter more economical logistical lines.[11] In the wake of that study, Congress recognized the strategic importance of these waterways and the responsibility of the federal government to pay for the development of our system.[12] In 1819, Secretary John C. Calhoun, called for a federal effort to improve specific critical waterways for strategic military reasons and economic development. Calhoun stated, "...government realizes its security in the beneficial effects from a people made prosperous and happy by a wise direction of its resources in peace."[13]

It was not until 1824, when the first waterway act was passed which involved the removal of various problem areas and, ultimately, became the beginning of federal dredging projects. This act afforded President Monroe the opportunity to specify the federal engineering agency to supervise the project. Since the

Corps of Engineers had done the study, it was chosen to be the lead agency and the effort was rationalized as a national defense issue.

During the Civil War, both Union and Confederate troops made use of inland waterways to transport troops and supplies. After the war, the aspect of dredging, as a means to keep waterways oper was realized as a strategic national defense issue. Post-war planning to rebuild the South included development of waterways to help the recovery of the devastated Southern economy. These projects were designed to provide new employment, restore commercial activity, strengthen national bonds, and assist in the rebuilding process.

The waterways continued to evolve through World War I and World War II. Money was put into building and maintaining more reliable waterways throughout the nation for defense and economic prosperity. These routes became extremely important when sea lanes were threatened during periods of global war.

Today, the United States has the most extensive domestic water transportation system in the world.[14] The strategic importance of our channels and waterways has not decreased; rather, dredging as a strategic necessity has increased as the call to revitalize the infrastructure surfaced during the last election. In the years ahead, the economic investment to keep vital channels open will continue to increase in importance. Dredging remains the solution to keep this system in operation.

PRESENT DAY

The economic well-being of the nation has now taken center stage. As Calhoun spoke of economic prosperity as a national security issue, so did all of the presidential candidates in the 1992 election. Foreign policy and defense issues took a back seat, and the campaign was seemingly won on economic issues. President Clinton stated that "foreign and domestic policy are inseparable in today's world."[15] He further stated that we must restructure our military force and reestablish America's economic leadership at home and abroad. He also makes reference to our export of a half-trillion dollars in 1991; almost 99% of that export was through our port system.[16]

America is physically located at the global crossroads. It serves to link Asia and Europe. In the next century, we will be afforded the opportunity to transform the United States into the logistic center for world trading.[17] This type of commitment would require an upgrade to our transportation system, and integral in this upgrade would be the deepening of our channels and waterways to accommodate deeper draft ships. Today's ships have increased greatly in size and draft: deeper draft, more efficient ships, are common throughout the world (see appendix I). Our channels must keep pace with this technology and we must dredge adequately to allow safe passage of these new types of ships. Key to that upgrade would be dredging and the need to dispose of the dredged material. It would facilitate the boom to our export and import business envisioned by our new president.

An essential link in the economic strategy of the nation is dredging.

In the next decade, trade predictions indicate increases of 200% by volume and 50% by amount of critical raw materials delivered by sea.[18] The Navy's primary purpose will be to keep the sea lines of communication open, but this job is counterproductive if ships cannot get into port. Access to the seas, free trade and economic importance are inseparably linked to the ability to dredge and keep our channels open.

U.S. Transcom is the agency tasked specifically with the maintenance of a strong defense transportation system and has cited maintenance of our merchant marine as the single biggest issue. It is the contention of this author that the mundane problem of dredging goes hand in hand with the success of the maritime industry.[19] Further, access to present day ports will cease if disposal of dredged material is not addressed. The Navy has recognized the extreme importance of dredging in its evaluation of base closures and home port options. To invest a great deal in a port facility when dredging could be curtailed or the price of dredging significantly increased becomes a major planning factor. For example, in San Francisco, the Navy recognizes the possibility of an increase in cost by as much as ten times over that now paid for routine dredging services. Shrinking budgets will not allow for that and alternate locations must be considered as cost effective porting alternatives.[20]

THE PROBLEM

Today, the U.S. Army Corps of Engineers maintains 11,000 miles of shallow draft channels in 655 harbors throughout the U.S. To do this, more than 300 million cubic yards of material must be disposed of annually, and an additional 150 million cubic yards are regulated yearly by the Corps.[21] Corps spokesman, Mr. Jimmy Bates, has stated, "Locating and retaining environmentally and economically acceptable disposal sites is the major management problem facing our national dredging program today and this is becoming more acute each year." The problem is monumental and very complex.[22] The maritime industry reiterated that disposal of dredged material is often the major problem for planners and operators in waterway development and use.[23]

The problem has become so acute that a New York editorial recently summarized what is occurring in many parts of the United States. It says that the United States will be the first nation in history to allow their ports to silt-in while they are still of vital need to further the economic well being of the country.[24] Presently, there are significant disposal problems in New York, Boston, Oakland, Baltimore, and San Francisco. Some facilities have become impossible to deepen because of economic, environmental, and legal confusion. For example, the "environmental ransom" associated with dredging of some San Francisco facilities cost so much that it exceeded the revenue for the facility.[25] In essence, the facility was no longer cost effective and should have been closed. The future of super ports

to be used for economic revitalization and increased efficiency is in jeopardy; in fact, maintenance of channel depth alone is now extremely difficult.

THE ENVIRONMENTAL DILEMMA

Since the 1960's, there has been an increase in awareness of environmental matters. Because of this, many laws-local and federal-have been enacted to insure environmental safety and many pertain to the dredging process. The National Environmental Protection Act was passed in 1969, and required an Environmental Impact Statement prior to actual dredging operations. This act put into effect a comprehensive and complex process that allows maximum participation by the public and special interest groups.[26]

The Corps of Engineers is charged under congressional authorities to dredge and dispose of material, and to regulate other private entities. There are more than 30 federal environmental laws, executive orders and other state requirements and laws that pertain to this process, making it extremely complicated and lengthy.[27] The process can be derailed at virtually any juncture by any federal or state agency, special interest group or individual, or delayed for additional expensive testing.

The principal authority to conduct dredging operations is found in Section 404 of the Clean Water Act (CWA) and is re-iterated in Section 103 of the Marine, Protection, Research and Sanctuaries Act (MPRSA), as implemented by 40 Code of Federal

Regulations (CFR), part 230 and parts 220-229 and 33 CFR parts 335-338. Other important regulatory acts of note include the Costal Zone Management Act and the Fish and Wildlife Coordination Act. These acts (and many more) create a virtual labyrinth designed to insure environmental safety.[28]

The United States environmental policy is characterized by tough and comprehensive approaches to environmental policy and rigid enforcement to protect the environment, while allowing environmentally sustainable development and maintenance of existing facilities. The real problems arise when the apparent abuse and inability to compromise creates gridlock or *mudlock*, as it is commonly called and resultant inaction.[29] Today, the U.S. has no single governmental agency with sufficient power over all other interests to make a final decision; as a result, today's plan gets undone tomorrow.[30] The real dilemma in the testing and legal maze is that the Environmental Impact Process causes agencies such as the Corps to be over cautious, and results in long delays. A wide variety of single purpose regulatory agencies, local and federal, and the courts, have the power to veto Corps decisions. Advocacy agencies often exaggerate the possibility of environmental harm, and because they are looking over their shoulder, the Corps (and other regulatory agencies) "play it safe" because they fear entangling lawsuits. The result is extremely expensive dredge disposal operations. Additionally, this lawsuit threat has resulted in larger and larger staffs to

prove and reprove test data, an action which further increases the cost of disposal.[31]

TECHNICAL BACKGROUND

There are numerous ways to dispose of dredged material dependent upon location and type of material to be disposed. I will mention four approaches: open-water disposal (deep ocean), bay-disposal (shallow water near shore), confined upland disposal (landfill), and beneficial use.

Each type of disposal option requires a significant amount of testing. Under the CWA, all dredged material is evaluated to determine the least costly disposal option, consistent with sound engineering practices and appropriate environmental quality standards. Under 404 (b)(1), unacceptable adverse affects to the aquatic environment will be avoided and all state requirements will be followed under section 401 of the CWA. In essence, this requires all materials to be tested prior to disposal.[32]

The approach is a 4-tier testing protocol to determine if sediments are acceptable for disposal and is based on scientific judgement, not baseline sediment standards.[33] This is the specific problem area, as scientific judgement is difficult to quantify. Additionally, as special interest groups proliferate, they produce their own "scientific experts" to support their several positions. This leads to conflict, which results in additional testing requirements, project delays, and almost certain litigation.

A description of the testing is necessary to understand the process. A discussion of the manner of disposal follows.

Ocean Disposal-

Tier 1: Existing information is evaluated to determine whether or not further testing is required.

Tier 2: Physical and chemical characterization to determine need for water column testing bioassay, and/or accumulation testing.

Tier 3: Acute toxicity (mortality) and bioaccumulation potential testing including: a) suspended particulate bioassay on relevant fish; b) 10-day solid phase bioassay on designated fish life; c) solid phase bioaccumulation on designated test animals (10 days for metals, 28 days for organic compounds).

Tier 4: Long-term tests to include: a) steady state, solid phase bioaccumulation if tier 3 indicates potential for bioaccumulation; b) solid phase testing for chronic sublethal impacts on organism growth and reproduction.

In-Bay Aquatic Disposal

Tier 1: Particle size determination (with exclusion of further testing of sand).

Tier 2: Sediment physical and chemical characterization and a bioassay with comparison to

reference site (other than disposal site) sediment. If not markedly different, no further testing required.

Tier 3: Bioassay and/or bioaccumulation testing with comparison to reference site sediment (usually disposal site). If no difference, no further testing required.

Upland disposal: Testing procedures which simulate disposal environment and evaluate containment pathways including: a) effluent analysis using modified elutriate; b) surface runoff characteristics; c) leachate characterization (ground water); d) plant and animal pollutant uptake and survival.

Beneficial uses: Testing procedures which simulate the type of use of the material, such as wetlands creation, dike restoration, landfill caps, etc. Upland disposal testing will be used in conjunction with in-bay or ocean disposal.[34]

The cost of testing is variable and is based on the type of project, maintenance or new work, type of material, extent of area to be dredged, history of the site, location and type of disposal site, required testing procedures and test results. Routine testing can be as little as $60,000 and take about 3 to 4 months to complete. On the other hand, new work testing (deepening existing channels) can take up to 24 months or more

and cost $4-5 million dollars. If there is any scientific question about the material, further testing is required which increases costs and delay. New projects are a risky business and tremendously expensive.[35] The need to insure acceptability requires a great deal of preliminary testing, followed by negotiations to persuade all scientists (or other interests) that the material will not cause harm. Often, a mitigation package or rescoping of a project is required, further increasing costs and delays.

ENVIRONMENTAL IMPACTS OF DREDGING

There are environmental resources that may be at risk during dredging activities. Dredging is not a benign activity; it disrupts habitats and redistributes sediments. These activities can significantly effect the coastal ecosystem and destroy marine life, especially sedentary invertebrates. These invertebrates are important parts of the food chain and contribute to the feeding of other fish; fish which are ultimately used for human consumption.

Other aquatic impacts of dredging include habitat loss when the sea bottom is altered. This occurs when dredged materials are deposited at a location and its material composition is altered. This decreases the diversity and abundance of certain species. Water circulation can be impacted when mounding occurs. This action can cause different siltation deposits and lead to the elimination of spawning areas. Turbidity, or the suspension

of sediments into the water column, can result in reduced light penetration and expose fish to abrasive materials.

Most importantly, dredging has the potential of releasing comparatively large doses of toxic substances into a new aquatic environment and to make them available to marine organisms. These materials include heavy metals, PCB's, pesticides, and other toxic materials that are certain to persist in marine life for quite some time.

Many species of marine life are sensitive to the impacts of dredging. The testing procedures previously described are designed to preclude the release of materials that could pose an unacceptable risk to marine life. The real dilemma arises as to how much is acceptable to the environment.[36]

THE SOLUTION

The business of dredging and disposal of dredged material is important to the strategic national defense. A strong maritime industry is crucial to our economic and defense strategy; it is also an integral part of the new administration's plan to revitalize the economy. Our ability to dredge is now at risk due to legal and environmental complications. The solution to this dilemma is unique in government and requires a tremendous amount of patience from regulators, environmentalists, and regulated community alike.

The approach is to find long-term dredge disposal solutions in an orderly manner. In the '91-92 budget, there were 33 high

priority funding requests for money to pursue a Long Term Management Study (LTMS) centered on finding long-term solutions to the dredge disposal dilemma. These studies are now given high priority due to national economic implications. Such places as San Francisco Bay and the Baltimore area are extremely sensitive because of the present controversy and previously cited economic and environmental implications. The need to dredge and maintain key defense ports is also in jeopardy.[37]

In order to meet the challenge of sustaining maritime activities in the country for military and commercial ship traffic, the Corps of Engineers has initiated a multi-participant disposal site planning process, the Long Term Management Strategy (LTMS), as codified in federal regulations (33 CFR Port 337.9).

The LTMS process has been initiated to preclude disaster and the stoppage of commercial and military shipping. Because the environmental and legal processes can halt dredging operations, a consensus building approach is required. To illustrate the difficulty of satisfying disposal planning, almost 40 interested groups are said to have a stake in the San Francisco Bay process. These groups include ports, labor unions, federal and state regulatory agencies, resource agencies, and special interest environmental groups. The process is complex and expensive, but results in the best possible solution to *mudlock* and may preclude serious disposal problems for the next 50 years.

What is unique about this process is that it recognizes the diverse interests of environmental regulatory agencies and

industry. It also recognizes that no single group has the power to make the necessary decisions, so the entire group must decide. This group is lead by the Corps, and could have as many as 40 interested participants at any one time.

This process has been strongly endorsed by prominent members of scientific and engineering groups as the only way to insure an optimal solution for the disposal of dredged material for the next 50 years.

LTMS is a 5-phase process to ensure that a comprehensive examination is made in each affected area. Each phase consists of a series of steps or activities that leads to a specific level of decision making before proceeding to the next phase.

Phase I-This is an evaluation of existing management options. This phase is intended to serve as the first level of appraisal and decision making. This phase puts limits on projects' analysis and decision making, including both geographical extent and time frame within which the analysis will occur. Once LTMS limits are set, the next step is to identify the dredging needs in terms of volumes, frequency, and dredged material characteristics for the projects within the study boundaries. Next, an identification of the existing site capacity should be made for a comparison of needs versus existing capacity. At this juncture, a decision can be made as to whether a need exists to formulate management alternatives (Phase II), or

to document the long-term practicality of an existing site.

Phase II-Formulated Alternative. The objective of this phase is to systematically develop and retain all viable long-term dredged material disposal options. Equal consideration to all management options will be given (upland, bay, ocean, etc.). All data associated with each option will be analyzed. At this, point a decision is made as to whether sufficient data exists to evaluate each option; if sufficient, the feasible options will be kept for further use. If not sufficient, data gaps will be identified, validated and screened based on various factors, such as potential for development and resources required to fill the gaps. After validity, the needed data collection must be planned. Invalidated requirements result in either no further evaluation of the management options or in follow-on research. All impractical alternatives are then eliminated, leaving only attainable and implementable alterations.

Phase III-Detailed Analysis of Alternatives. This phase provides for a thorough analysis of existing dredged material disposal management plans and the detailed evaluation, screening, and selection of a preferred long-term dredged material management strategy. This analysis should balance economic, engineering, and environmental factors and benefits. This phase selects the most practical

strategy of one or more alternatives for implementation and provides the necessary documentation needed to support the selection.

Phase IV-LTMS implementation. This is the operational plan for implementation and includes:

(1) Administrative, procedural, management, and monitoring requirements.

(2) Environmental documentation for the life of the plan.

(3) Long term water quality certification.

(4) Site specifics and regional permits/authorization.

(5) Formalized regional mitigation strategies.

(6) Implementation of site management requirements.

(7) Streamlining of permit processing procedures.

Phase V-Periodic Review and Update. The final phase is the periodic reevaluation of the LTMS plan, based on changing regulatory, economic and environmental conditions, and new technology. This phase ensures currency of the strategy for the length of the plan.

Some environmental advocates believe that man has encroached enough on the ecosphere and he should stop now. A member of Representative Ron Dellum's staff commented about this when he forged a compromise in dredging of the Oakland Harbor. For some radical environmental groups the dredging dilemma will never be

solved by scientific studies; to these people, it is not a scientific problem, it is a theological issue. It is extremely difficult to negotiate with fundamentalists. There are also some shippers and long-time dredgers who still profess that dredging has no ill-effect what-so-ever; "It came from the ocean floor and we are just redistributing it." Although there is truth on both sides, the workable solution is LTMS and compromise.

What does LTMS do?

LTMS is cost effective-it provides an environmentally sound solution at a reasonable cost. The LTMS study program is underway in San Francisco; it will cost more than $10 million and take almost 4 years to complete. Although it may seem incredibly expensive and long, a similar project where LTMS was not used bears mentioning. The Hart-Miller Island disposal project in Baltimore took more than 16 years and a legal battle that went to the Supreme Court. An orderly consensus building-process like LTMS looks a lot better when put in that light. The Baltimore disposal site will last only a few years, and the San Francisco sites will last 50 years. In the long run, the investment becomes quite cost effective.

Environmental groups since 1969 have been litigation oriented. They have successfully enacted laws and regulations to insure that dredge material disposal is done in a safe and environmentally acceptable manner. Their focus has been one of stopping Government or the private sector action until suitable

changes are brought about, usually mitigation or rescoping of the project. In extreme cases, they stop the project all together.

The dredger has been focused on the most economically and legally sufficient approach to dredging.

The LTMS process requires both sides to assume compromise positions. For the first time, environmental groups must build the solutions, not just litigate and stop a project. For the first time, builders must recognize that environmental factors are just as important as economic factors. By using the system, future litigation will be curtailed. This plan will allow planners the assurance that is necessary for future projects and maintenance of present channel depths. This strategically important transportation system will insure that efficient transportation of our goods will be possible in the years to come.

CONCLUSION

Our national security strategy envisions a robust and growing economy, wise environmental stewardship, and a strong military as part of its plan to meet the nation's security needs in the 1990's. Maritime activities are a nationally significant institution which is crucial to this strategy, economically and militarily. All maritime activities in the United States face a tremendous challenge in the future. Solutions to the dredge disposal issues must be found that allow us to keep our channels open but do not result in environmental degradation. The Long

Term Management Strategy for the disposal of dredge material brings all interested parties together to arrive at a 50 year plan to insure the viability of this key link in our National Defense.

Endnotes

[1]John M. Pisani, Port Development in the United States. (Tokyo: The IAPH Foundation, 1989), 1.

[2]Ibid., 27.

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[20]Taken from an interview with CAPT Robert Moeller, Commander WESDIVNAVFAC, San Bruno, California, on 7 January 1993.

[21]Data taken from USACE Civil Works fact sheet dated, 30 January 1992.

[22]Taken from a speech given by Mr. Jimmy Bates, Chief of Planning, USACE, to LTMS National Forum, January, 1991.

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PORT OF OAKLAND

Containership Evolution

Length

1ST GENERATION

- Converted Dry Cargo Vessel (Pre-1960) (16 KTS) — 450'
- Converted Oil Tanker (1960-1970) (16 KTS) — 630'

2ND GENERATION

- Cellular Containership (1970-1980) (23 KTS) — 700'

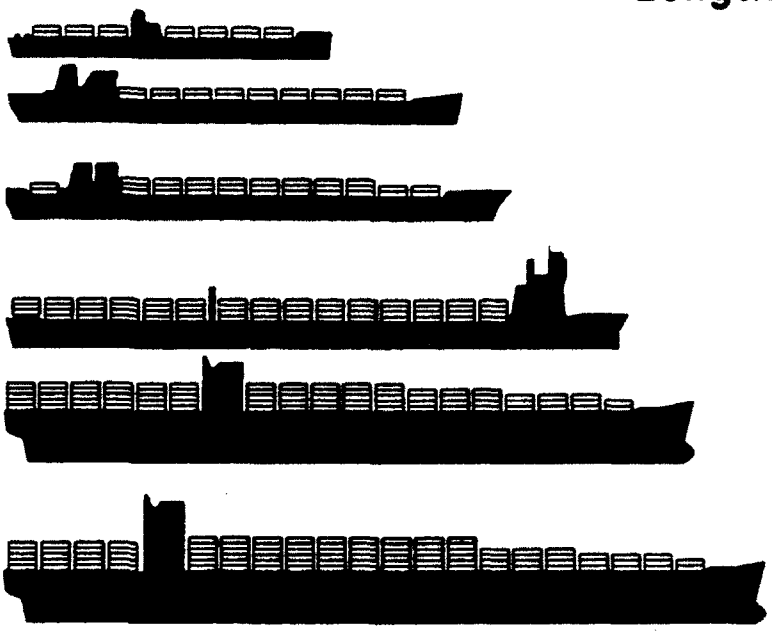
3RD GENERATION

- Cellular Containership Panamax Class (1980-1990) (23 KTS) — 860'

965'

4TH GENERATION

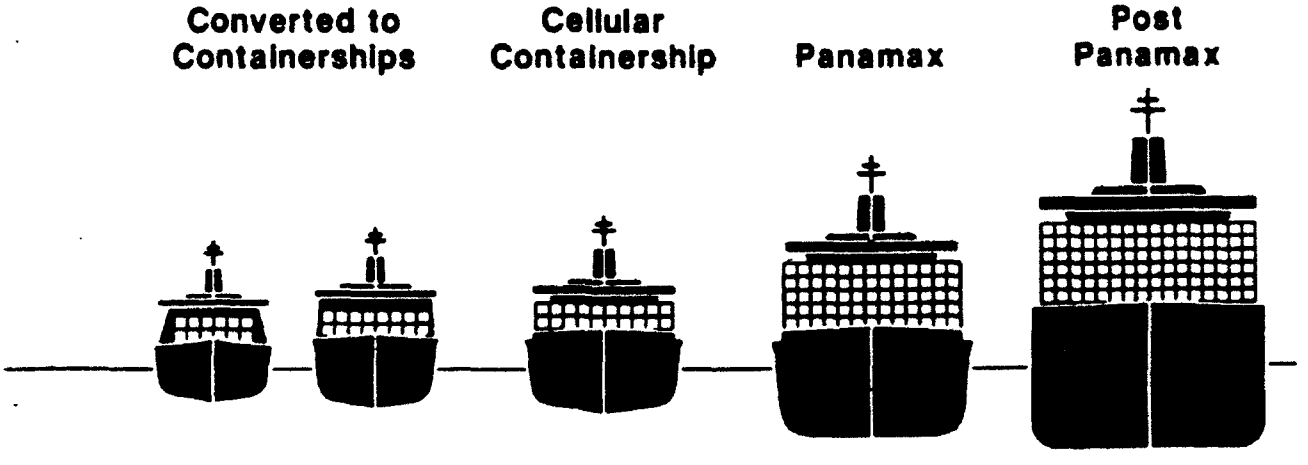
- Post Panamax (1988-1995) (23 KTS) — 900-1000'



PORT OF OAKLAND

Containership Evolution

Beam Size and Draft



	Converted to Containerships		Cellular Containership	Panamax	Post Panamax
Beam	76'	90'	90'	105'	135'
Draft	Less Than 30'	30'	33'	38'-41'	38'-42'